Space Weather Technical Forecast

Issued on Friday 7 February 2025 at 01:19 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 Expected. Chance of S1. Increasing Chance of G1/G2 Geomagnetic Storms into UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured by GOES16 and 18 was Moderate over the past 24 hours, with two M-class flares from AR3981, the largest M7.6 at 06/1104UTC.

There are currently ten numbered sunspots on the visible disc, with previous AR3974 now faded from view and AR3987 near the east limb recently numbered. The largest and most magnetically complex regions are clustered close together in the northwest quadrant, and are entwined so analysis of individual regions is tricky. However, AR3981 remains clearly the largest region on the disc and with the greatest magnetic complexity, with one clear Mt Wilson delta spot within an intermediate spot group. There are two smaller regions (AR3977 and AR3984) which have moderate magnetic complexity, while the rest on the visible disc are small and magnetically simple. Most regions have been stable or shown slight decay, except for AR3981 and AR3984 which have shown minor increases in spot number and area.

A CME was visible on coronagraphs from the M7.6 flare. However, confidence is low regarding the analysis of this CME as it was very faint in the limited imagery available. Currently there appears to be a slow, weak Earth directed component to this CME, potentially arriving late day 4 (10th).

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, where predominantly at Slightly Elevated speeds between 430-480 km/s, peaking briefly at 500 km/s at 06/1815 UTC. The cause of this enhancement is uncertain, possibly from a glancing interaction with the M4.1-related 02/2320UTC CME from AR3981, but also maybe from an unidentified coronal hole feature.

The solar wind density was initially at average values, but did briefly reach above average at 11 ppcc at 06/0757 UTC, then falling to generally below average levels. The IMF was predominantly at moderate levels, reaching a peak of 11nT around 06/0330UTC , until the evening and then declined to become weak. The north-south component, Bz, initially fluctuated and varied between +/-6nT, but then settled to become predominantly positive during the second half of the day.

The net result of the above solar wind measures was Quiet to Unsettled (Kp 1-3) geomagnetic activity.

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Energetic Particles / Solar Radiation: High energy proton flux at GOES18 remained at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at Normal Background to Moderate levels, peaking at 168pfu at 06/1250UTC. The associated 24-hour fluence persisted below the Active threshold, recording 3.14e6 integrated pfu at 07/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with further M-class flares, primarily from AR3981, and with an ongoing Chance of an X-class flare.

Solar Wind / Geomagnetic Activity: Two CMEs feature in the forecast - firstly the CME associated with a filament eruption in the southwest from early on 05 February, which has a low chance of delivering a glancing blow late today or into tomorrow (Friday 07 into Saturday 08 February). The other CME is associated with the M7.6 flare from AR3981 on the 6th, which may arrive late on day 4 (10th). Both events are low confidence.

A high speed stream (HSS) from CH13/- is expected to arrive during day 3 (9th), most likely during the second half of the day. Solar winds are expected to become elevated, to potentially strong, in association with this feature and persist through the remainder of the forecast period.

Predominantly Quiet (Kp 0-2) geomagnetic activity is expected, then potentially increasing Unsettled to Active (Kp 3-4) for a time late today or into tomorrow (Friday 07 into Saturday 08 February). Activity is then expected to increase again during days 3 and 4 (9th and 10th) due to HSS and CME influence, becoming Unsettled to Active (Kp 3-4) with occasional G1-G2/Minor to Moderate Geomagnetic storms (Kp 5-6) intervals likely.

Energetic Particles / Solar Radiation: There is an increasing Chance of S1 events , as the cluster of sunspots in the northwest rotate into a better-connecting position with Earth.

High energy electron flux observed at GOES16 has remained at Moderate peak levels and has perhaps now peaked in relation to CH11/+. Geomagnetic activity and inbound CMEs should mean that there are no further drivers until the new working week in the wake of CH13/-. The corresponding 24 hour fluence is expected to persist below the Active threshold.

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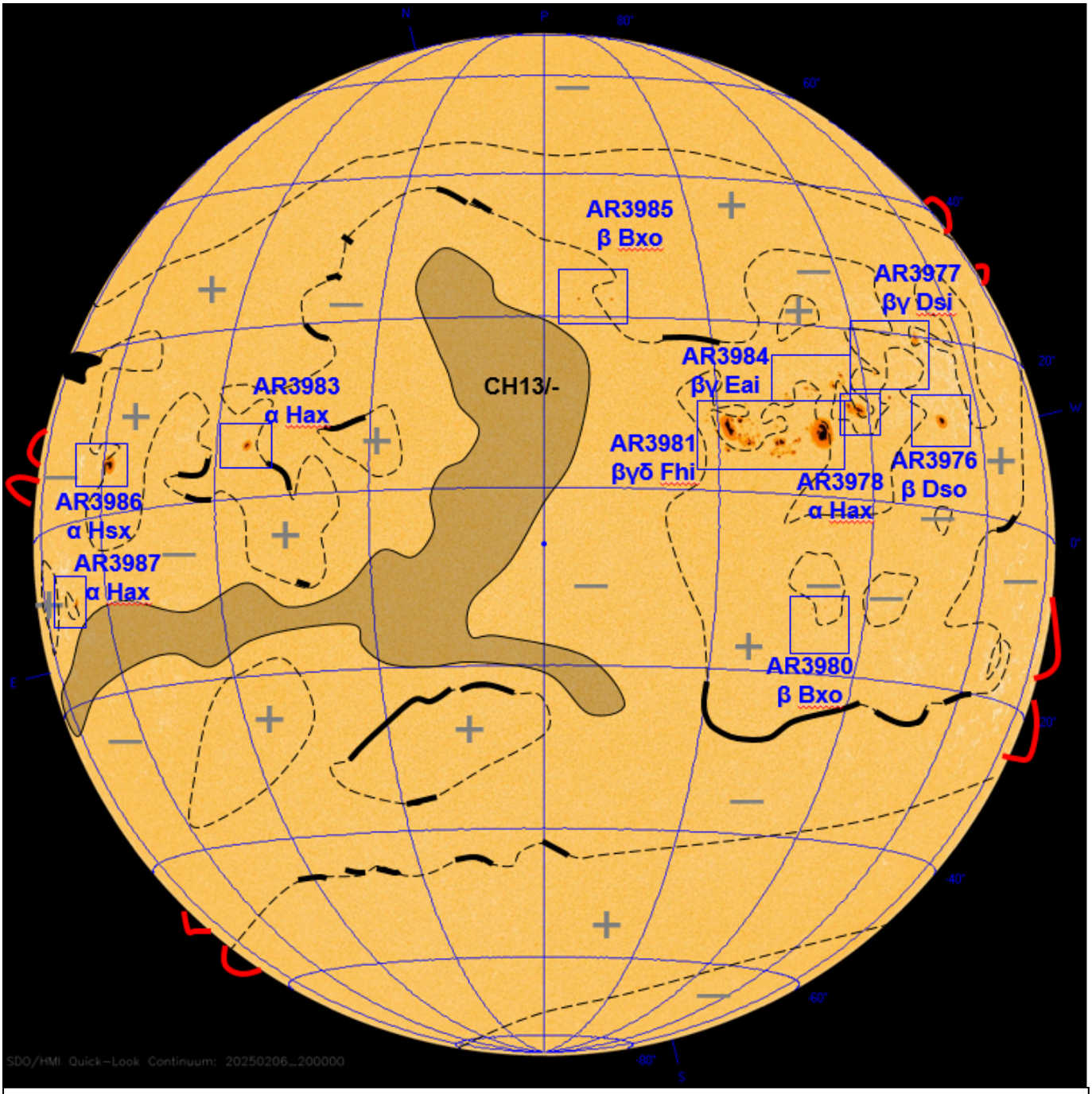
Figure 1: Synoptic Map valid 06/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME from a filament eruption in the southwest, from early on 05 February, has a low chance of delivering a glancing blow late day 2 or day 3 (Friday 07 into Saturday 08 February). Given the apparent amount of material which erupted from this filament, should it arrive at Earth it could give a noticeable impact. Another CME associated, with the M7.6 flare from AR3981 on the 6th, may arrive late on day 4 (10th). Both of these events are low confidence.

The next recurrent feature, CH13/-, is expected to arrive during day 3 (9th), most likely during the second half of the day. This feature appears to be larger and more intense compared to the previous rotation, when speeds reached around 450 km/s. On this rotation solar winds are expected to become elevated 500-550 km/s, to potentially strong at 600 km/s, in line with MOSWOC Enlil expetations. However, Enlil is considered too fast for the HSS arrival at Earth.

Predominantly Quiet (Kp 0-2) geomagnetic activity is expected, then potentially increasing Unsettled to Active (Kp 3-4) for a time late today or into tomorrow (Friday 07 into Saturday 08 February). Activity is then expected to increase again during days 3 and 4 (9th and 10th) due to HSS and CME influence, becoming Unsettled to Active (Kp 3-4) with occasional G1-G2/Minor to Moderate Geomagnetic storms (Kp 5-6) intervals likely.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	60	50
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
03/0457	Partial	AR3981	NE	590	Perhaps arrived/arriving UTC morning of 06 February	Probably arrived on the 6th.
05/07:00	Partial	Filament	SW	790	08/0000 +/- 6 hours	Low chance of glancing impact.
07/0200	Partial	AR3981	NW	300	10/2100 +/-12 hours	Low confidence.

Figure 2: Latest MOSWOC Enlil model.

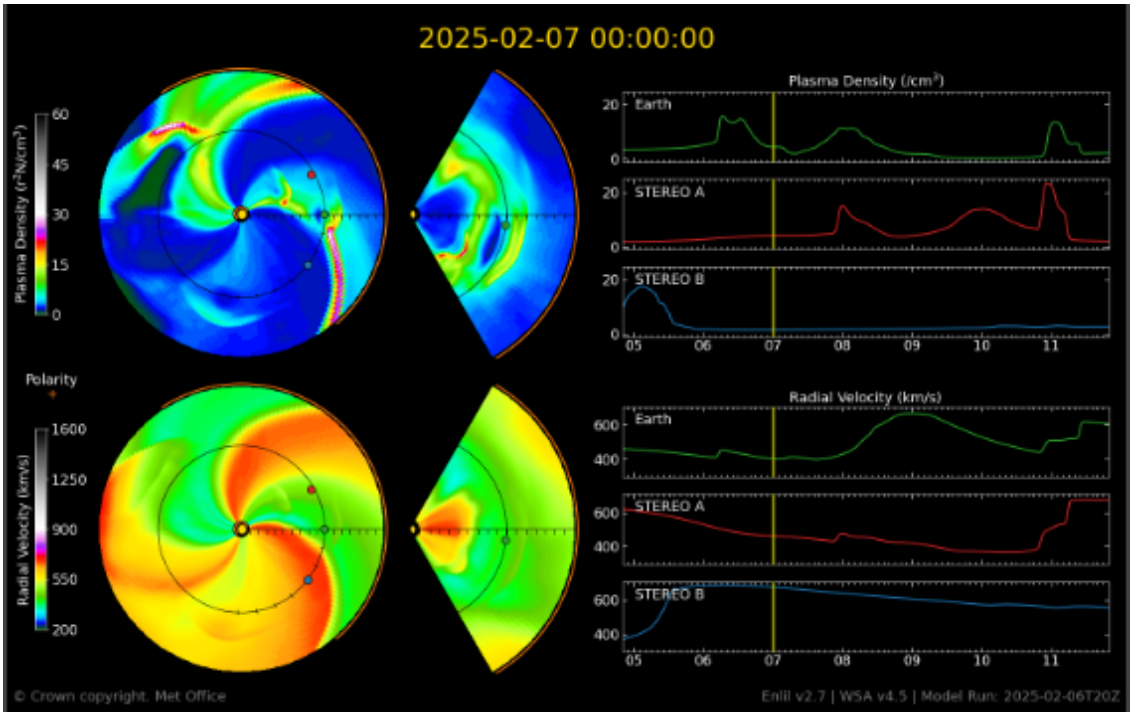

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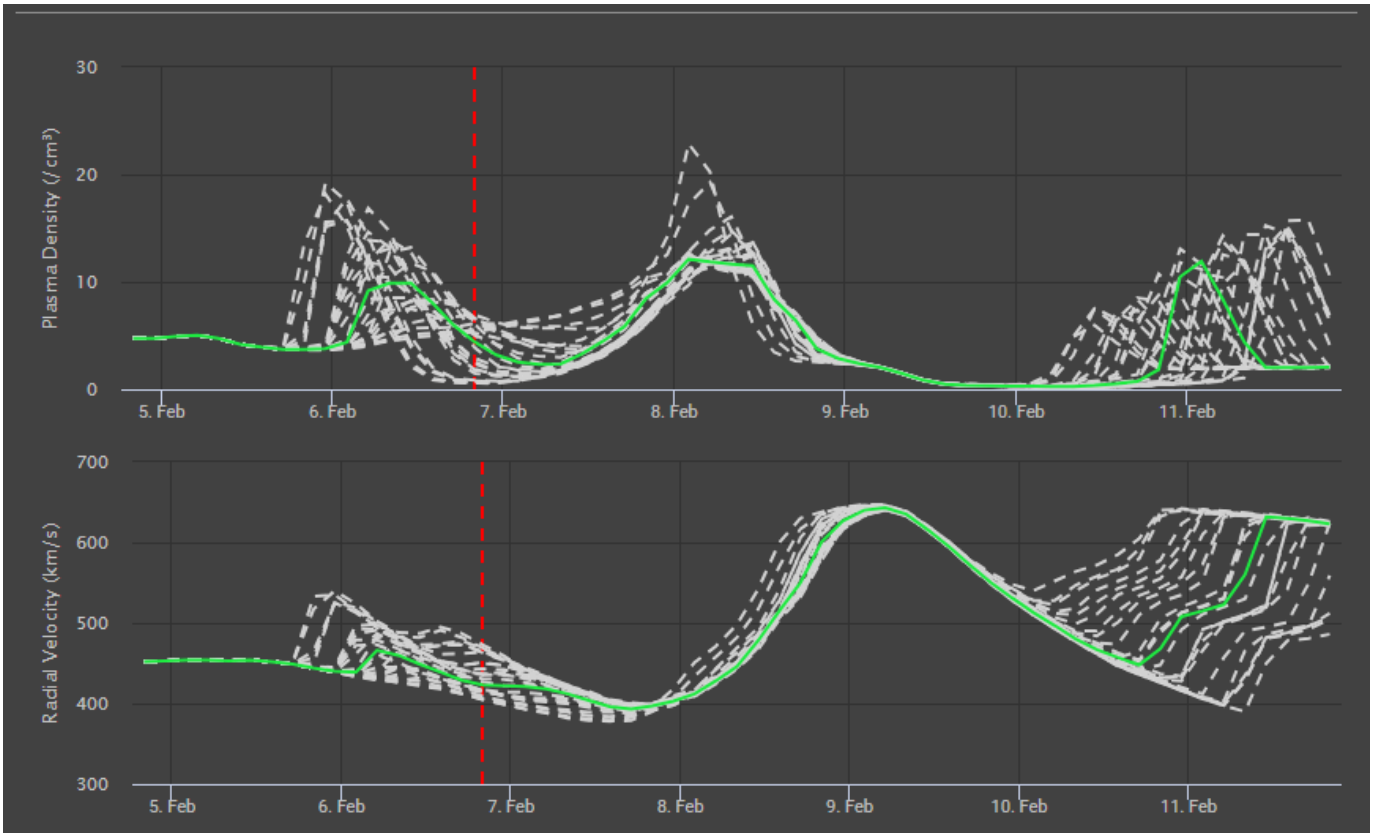
Figure 3: MOSWOC Enlil Ensembles indicating the uncertainty regarding the CME arrival late on the 10th.



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Radio Blackouts - X-Ray Flares

There are now ten active regions on the Earth-facing disc, with AR3987 recently numbered. The northwest remains the dominant quadrant, with a cluster of entwined regions containing AR3981. AR3981 remains the largest region on the visible disc, with recent slight growth in spot number and penumbra within intermediate spots. AR3981 is also the most magnetically complex on the disc, with a small but strong and clear Mt Wilson delta spot within an intermediate spot, immediately behind the lead spot. There is also possibly a secondary weaker delta spot within another intermediate spot. AR3981 has also recently elongated slightly, and is now classified as Fhi/Beta-Gamma-Delta classification persists for AR3981. The region immediately to its north (AR3984) continued to show slight growth in small leading and central spots, and remains an Eai/Beta-Gamma. The other regions in this northwestern cluster, meanwhile, either showed slight decay or where stable. The remaining regions on the disc are small, stable and magnetically weak.

None of the main front-sided regions depart the disc during the period. Recurrence suggests the potential for one or two returning regions due, perhaps further evidenced by a far-sided southeast-headed CME in the past 24 hours, however far-side helioseismic output has no strong signals for particularly significant groups.

Solar activity was Moderate over the past 24 hours, with a M7.4 from AR3981 at 06/1104UTC. Further M-class flares are Expected primarily from AR3981, and with an ongoing Chance of an X-class flare.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	20	20	20	20

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Figure 4: GOES X-Ray flux for the past 24 hours.

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Solar Radiation Storms (High Energy Protons)

There is an increasing Chance of S1 events , as the cluster of sunspots in the northwest, including AR3981 the most active and most likely region to produce a significant flare, rotate into a better-connecting position with Earth.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at Background to Moderate levels. The next likely charging mechanism for the Van Allen belts is CH13/-, but any subsequent significant rise in electron levels is expected to be beyond the current forecast period. Possible CME arrivals in the interim complicate this picture somewhat, but this will most likely result in more frequent Background flux at GEO before any CH13/- effects are felt.

The corresponding 24-hour fluence is expected to persist below the Active threshold. MOSWOC REFM output shows levels well below Active through the next 72 hours, however this will not account for intervening CMEs nor the increased intensity of CH13/-, although the latter mainly falls outside the REFM forecast period. REFM can be considered a good proxy should the inbound CMEs miss Earth in the meantime - i.e. a continuing unremarkable electron trace at GOES16.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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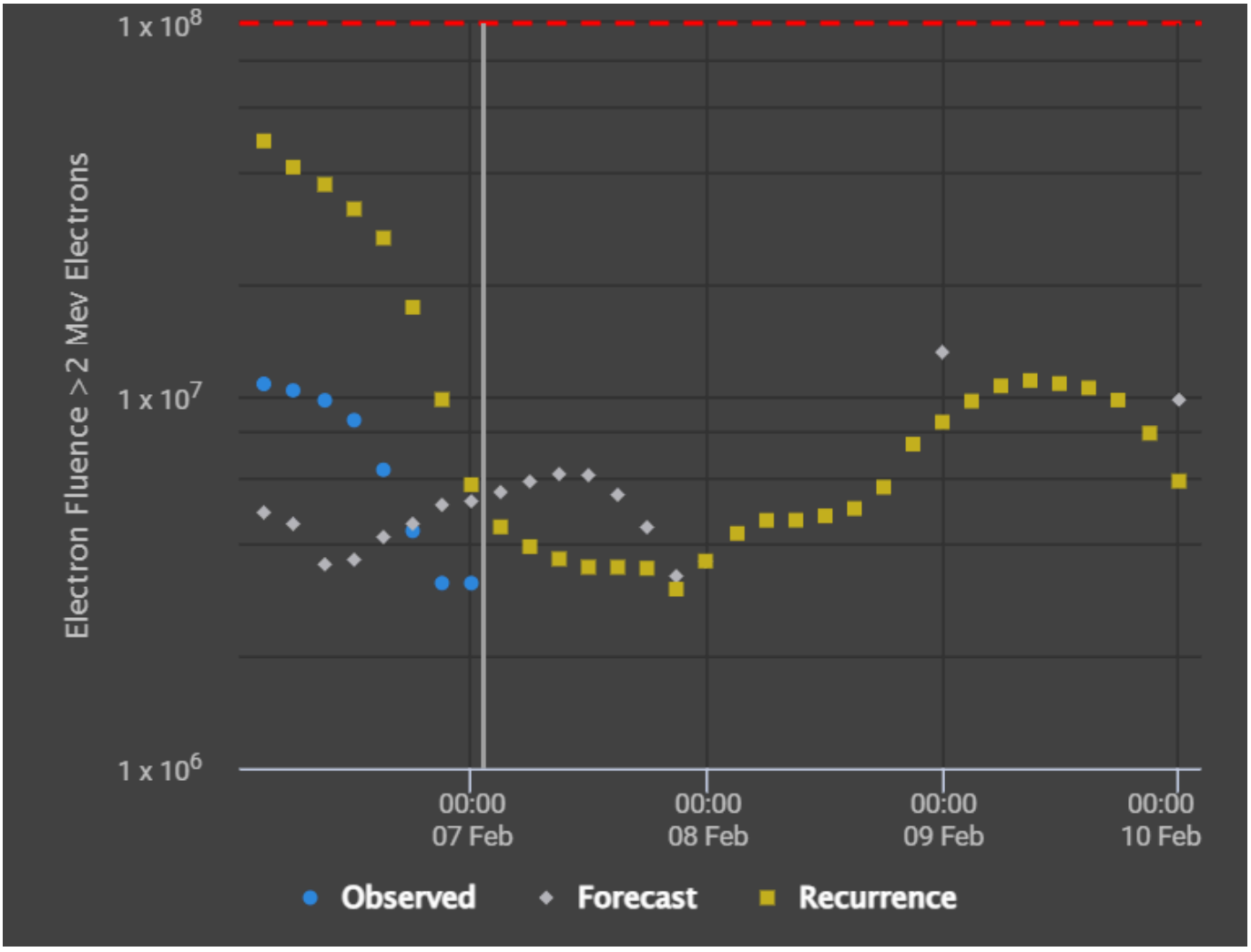
Figure 5: Latest MOSWOC REFM model.



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